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ART.

IF science is systematised knowledge, art is applied knowledge, or the application of universal laws to particular facts. It is derived from *ars*, strength, the primary sense of power, and therefore of skill. It is the modification of things by human skill to serve some intended useful purpose. There are many branches of art as there are of science. Thus we have the art of shipbuilding, of gardening, of painting, of engraving, of printing, of telegraphy. And not only have we the art of producing, but that of criticism, or of testing the genuineness, truth, or correctness of things done by others. A judge of pictures tests the truth of a production before him, by comparing it with certain laws that he has learnt from observation, or has been taught by experience; and an electrician tests the value of an instrument submitted to his inspection, by comparing it with certain principles or conditions that he has acquired by his scientific training. A scientific training increases many times the pleasure produced by an inspection of the beautiful productions of ancient and modern skill. The telegraph engineer invents a certain instrument by applying those particular facts that observation and study have brought to his notice, and the telegraphist applies his art in making use of the instrument so invented. Universal laws and particular facts are the extremes both of science and art, but science ascends from phenomena to conditions, and art descends from conditions to phenomena. Telegraphy may be both a science and an art. It is a science when it gathers laws from particular facts; it is an art when it applies those laws to particular facts. Thus Ohm laid the foundation of the science of electric currents when he developed the laws of resistance, and Varley developed the art of testing when he applied those laws to determine the distance from the shore of the broken end of a cable. Faraday determined the science of magneto-electricity when he discovered the fact that currents can be produced by the motion of a wire in a magnetic field, and Wheatstone improved the art of telegraphy when he applied those currents to work a simple alphabetical dial. In the development of science the mind is more exercised than the body; in the development of art the hands or body are more concerned than the mind. There are the useful arts and the fine arts—the former, besides the various trades, include telegraphy, and the latter comprehend those productions of human genius and skill which are addressed to the sentiment of taste or to the imagination. In fact a science teaches us *to know* and an art *to do*, and all the more perfect sciences lead to the creation of corresponding useful arts. Psychology is the basis of the art of education, physiology is the foundation of the art of medicine, astronomy leads to the art of navigation, and heat to that of railway locomotion. Chemistry is the root of many useful arts, and electricity is the foundation of the art of telegraphy. Although the primary position has been given to science, it must not be forgotten that art is usually the precursor of science, and that it is from the art itself that the science has often been evolved. The fact that science is systematized knowledge implies the existence of isolated facts upon which the mind is able to generalize, and these facts are usually the consequence of the pursuance of the arts. Hence an expert in the art by no means implies an expert in the science, and unfortunately the two are rarely combined, especially in the telegraphic world. It is a very regrettable fact, for none have such opportunities of acquiring a knowledge of the science of electricity as those who are engaged in pursuing the art of telegraphy.

ON TELEGRAPH CONSTRUCTION.

By JOHN GAVEY.

(Continued from vol. iii. page 295.)

4.—DISTRIBUTION AND LAYING OUT OF STORES.

THE survey being complete, the consents obtained, and the stores selected, the next operation in the construction of a line is the distribution and laying out of the materials.

In a line to be erected along the highway, it becomes necessary to select, at convenient distances, say fifteen or twenty miles apart, temporary store depôts, for accumulating the smaller stores which it would be unsafe to leave exposed to possible depredations or damage. These depôts should be selected with regard to the facility with which the stores can be collected, either from an adjacent railway station or canal, and with which they can be distributed as required over the work as it proceeds. Poles, wire, and such like heavy materials, the cartage of which is costly, should be sent to the nearest railway or canal stations along the route, independently of the sub-depôts previously referred to; the length of the poles and

the quantities of wire sent to each locality being determined from an inspection of the survey book.

Contracts should then be entered into for the cartage of the materials; and in dealing with poles it is far preferable to arrange for the payment of a certain price per pole for delivery over a given length, than simply to hire horses and timber wagons by the day. With the former plan much more work will be got over at a much less cost, by the contractor's men, than by the latter. In determining the amount to be paid for each pole, the average size and weight of these, the value and cost of haulage in the neighbourhood, the season of the year, the state of the roads, and the number of turnpike tolls, as well as the length of each section to be served, must be considered. The lighter stores had better be delivered by day work as the progress of the line demands.

In laying out poles and wire on a public road, great care must be taken not to obstruct either the public way or the water-courses; and the materials should be so placed that no danger of accident either to horse traffic or foot-passengers may arise. Cases have occurred where poles lying by the side of the road have been moved across it by mischievous persons, it is therefore sometimes advisable to tie these and the bundles of wire, back to the hedges and fences by pieces of scrap wire, so as to prevent those who are simply mischievous from interfering with them. The difficulty, without a pair of pliers, of severing a piece of ordinary telegraph wire, twisted tightly around any object, is sufficient to discourage this class of individual, fortunately the only ones we have to dread.

On railways, a different course is pursued. The line being private property, from which the public are rigorously excluded, all the stores may, if necessary, be laid out before hand without danger of their being removed or otherwise interfered with.

Two methods are adopted for distributing the materials, one by *trollying* them out, the other by the use of a special train. In the former, the necessary stores for the intermediate sections, as indicated by the survey book, are despatched to each station, care being taken, if the railway has long and steep gradients, to send the largest quantity of materials to those stations at the highest end of each gradient. They are then loaded on trollies, run out at convenient times between the trains by half a dozen men, and deposited as required. The cheapest, quickest, and most satisfactory method of laying out stores on a railway is, however, by means of a special train. In doing this, the total number of poles required for the work is loaded, all similar lengths being kept together on the same trucks, with their butt ends pointing toward the tail of the train. The lighter stores are prepared by being tied into bundles, the requisite number of arms, bolts, insulators, &c., for every pole being tied into a separate bundle by pieces of scrap wire. The truck containing the poles should be placed next the engine; those containing the wire following; and, lastly, those in which the lighter stores are placed. Two men are stationed on each truck containing a given length pole, two in the wire truck, and as many as may be necessary for the smaller stores. The train being started, the officer in charge of the work stations himself in a conspicuous position, and from his survey book signals to his men the length pole to be dropped opposite each survey mark. The butt of the pole is raised off the truck and allowed to fall on the ground, without the train being stopped, the onward movement of the latter causes the upper end of the pole to slide gently off, and it drops without danger.

The object in having all the butts in one direction is to aid this action, for were they pointed towards the engine, they would wedge themselves and cause much difficulty. The men in the wire trucks drop a certain number of bundles, according to previous instructions, at each quarter mile post, these bundles being dropped flat, so as to prevent rebound and the possibility of their rolling under the train. At each pole that is laid out, the men at the tail of the train drop the necessary bundles of smaller stores, so that the whole materials are placed where required at one operation.

The train should maintain a speed not exceeding four miles an hour, and should always be under good control. Where possible, the trucks should all be tightly coupled up, like a passenger train, to avoid that jolting in stopping and starting that is so conspicuous in goods trains, and which is very dangerous for the men employed in laying out the poles. Flagmen should follow the train at a distance of 1,000 yards, provided with all means of stopping any other train which may appear in sight; and, in arranging the periods of running, due allowance of time should be made, so that accidental stoppages of reasonable duration for any purpose may not impede the ordinary traffic. The flagmen should likewise see that everything is clear of the following traffic as they proceed in the wake of the train.

A couple of men should then traverse the length and place all the materials together in an orderly manner, where they may remain undisturbed until their actual use, the insulators being so placed as to exclude rain and dirt from the interior of the cups.

On canals, poles, wire, and heavy materials may be laid out from barges where required for use, but discretion will have to be used as to whether the lighter stores should be so dealt with, or whether they be distributed as required.

(To be continued.)

ON A SYSTEM OF TELEGRAPHY.

A Course of Lectures, Delivered at the School of Military Engineering, Chatham. By W. H. PREECE, Member Inst. C.E., &c.

Lecture IV.—A. On the Application of a System of Telegraphy to National Purposes.

(Continued from page 8.)

I have now to allude to the application of a system of telegraphy to national purposes, and, indeed, it must be an allusion only, for a full development of the subject would of itself require a course of lectures.

I mentioned that one of the first purposes to which the electric telegraph was applied in England was to replace the uncertain line of semaphores used by the Admiralty between Portsmouth and London. This was done as much for the imperial

purposes of State as for the departmental purposes of the Admiralty; and, as soon as telegraph wires were carried in those directions, the same connection was made between Whitehall and Devonport, Deptford, Chatham, Sheerness, and Dover. These wires, during the Crimean War and the Indian Mutiny, played a most important part in furthering the movements of our Navy and perfecting the equipment of our ships.

But a national system of telegraphy is as applicable to our ships of peace as to our ships of war. The number of ships that arrive daily in the ports of this kingdom is enormous, and each of them is a subject of concern to numerous persons connected with it. Thus, the owner is anxious to know of the safe arrival of his vessel, the agent may wish to change her port of arrival, the friends and relations of her passengers and crew are anxiously awaiting knowledge of their return, and the shippers and consignee of the safety and value of the cargo she carries; the underwriters who have insured the ship, and the purveyors who are anxious to supply her with fresh stores, as well as the press itself, are eager to receive the earliest intimation of her arrival.

The arrival of a mail steamer is also a matter of concern to the dockmaster who has to provide a berth for her, to the railway company which has to find a train for the transport of her mails, and the Post Office, which has to despatch and deliver those mails. At large ports like Liverpool where quay room is of immense importance, and quick discharge is therefore necessary, a system by which the early arrival of a ship can be known is of the utmost importance.

Hence signal stations have been applied at different points of the coast of England which have been connected with the ports to which they belong by means of telegraphs. In this way, as early as 1827, the Mersey Dock Board established a system of signalling between Liverpool and Holyhead, which was originally worked by a line of semaphores, but which has of recent years been replaced by an electric telegraph. Hurst Castle, as far back as 1852, was connected with Southampton in order to afford the earliest announcement of the arrival of the mail steamers making that port their point of departure. Browhead and Roches Point, on the south coast of Ireland, were established in order to afford to Queenstown and Liverpool the earliest intimation of the arrival of the Atlantic mail steamers, and, more recently, stations have been established at the Lizard and St. Catherine's Point, to announce the arrival of homeward bound vessels making the Channel their route homewards. All these systems have been established at different times by different people, and have been worked on irregular methods, not uniform in any way in their character. The Post Office Department is about to assume the management of most of these stations, and to establish them upon a uniform and systematic method, forming the nucleus for a grand national system of signalling ships about our coasts. Such a system of signalling is useful for numerous purposes beyond those appertaining to the arrival of ships; for the establishment of meteorological stations, to give warning of the approach of storms, to give intimation of the positions of vessels in distress, to announce the arrival of those immense shoals of fish which form such a source of wealth to portions of the population, to assist the life boat in its humane services, and, in times of war, to watch and guard our coasts, to secure communication with those ships which patrol our shores, and to direct fleets to the position of the enemy.

A very complete system of ship signalling, in connection with telegraphs on shore, has been established around the coast of France and upon the coasts of Italy, and it is unfortunate that the first maritime nation in the world should be behind its European neighbours in establishing a grand national system for the protection of its commercial navies.

It might even become necessary for the War Department to assume the entire control of the commerclal system of this country in the event of any political disturbances taking place, which fortunately however, are of rare occurrence in this country. During the Chartist riots in 1848, the telegraphs were assumed by the Government, in order to be prepared to meet any contingency which might arise. The system was small in those days, but still throughout the Midland counties various arrangements were made; the civil were placed in communication with the military authorities in the provinces; temporary stations were fixed under the railway bridges in order to be prepared for the seizure of the offices by the mobs. but fortunately no occasion occurred to make use of the preparations that had been made.

Correct time is sent daily by a special wire from Greenwich to T S, and there by a cronographer it is distributed all over the kingdom. At 10 a.m. every morning a single throb of electricity permeates the whole of the telegraphic system of this country, conveying by one simple pulsation, originating at the Royal Observatory, Greenwich time to the most distant parts of the kingdom.

B. Its Application to Military Purposes.

The remarks that I am about to make upon this branch of my subject are intended to be inferential and critical rather than didactic.

The history of the military system of this country is much better known to yourselves than it is to me. The lectures which have been delivered by Colonel Stotherd and Majors Malcolm and Webber, and the information contained in your own reports, give full details of the arrangement and construction of your military telegraphs. My object is rather to draw lessons from what has been said about other systems and to apply those lessons to the organization of your military telegraphs. Every system of telegraphy, for whatever purpose it is used, is, as I have said before, simply an example of natural selection, and the rate of growth of education, or the advance towards perfection, is proportionate to the amount of experience gained. If a thing be designed, constructed, and then laid upon the shelf it cannot be improved; it remains in *statu quo*. But if it be incessantly examined, proved and used, its little imperfections will be developed, its defects will suggest remedies, it will invite scientific thought, and it will approach perfection. This is the effect of experience. Your experience being so small it has been necessary to avail yourselves of the experience of others. Thus, knowing what the various military nations of Europe have done, lessons can be gained from

the operations of the French, of the Germans, and of the Italians. I have alluded to the great success of the Germans, but I must distinctly point out that this success is in no way due to any display of inventive genius, or of original design, but simply to close application and rigid attention to the teachings of experience.

Our own Autumn Manœuvres have been too short to obtain much advantage from them. The experience gained has not been sufficiently continuous to be of much use. Experience to be of value should be sustained.

The control of every year's manœuvres has been characterised by a change of officers in command. Thus, in the first year the operations were under the control of Colonel Stotherd, in the second year under Major Webber, in the third year they were conducted on Dartmoor by Captain Durnford, and on Cannock Chase by Major Malcolm. The experience gained by one officer has been useless to another; each officer commenced his inspection and supervision from different points of view; their opinions and conclusions were probably not communicated to each other; hence this change of head has led to loss of experience. It must never be forgotten, and I cannot too often insist upon the fact, that telegraphy is essentially a child of experience, and its lessons are only to be learnt by sustaining that experience. There is not a day that passes that some new fact, some great weakness, some novel requirement, are being developed, necessitating scientific thought and practical knowledge to comprehend, to remedy, and to meet.

One fact connected with your system of military telegraphy is very patent to those outsiders who have something to do with it as I have. There is an evident want of unity, or rather of uniformity, in dealing with telegraph matters. For instance, you have at Chatham a very excellently equipped and well doing school, where the men are passed through a course of training of 100 days, and probably at the end of that period are very useful and valuable telegraphists; but who can say what becomes of them afterwards? They are not, as a rule, draughted to new positions where they can make use of or improve the knowledge they have gained. They do not receive that finishing touch, nor are they engaged in that constant application which is necessary to maintain them as useful telegraphers. Officers are supposed to be turned out efficient telegraph engineers in ten days; but inasmuch as my experience shows that ten years are hardly sufficient for such a purpose, it is difficult to see how it is possible to make even a moderately useful telegraph engineer in ten days,

A whole division of the Postal Telegraph system has been placed under the control of Major Webber, and this extensive district is maintained by Royal Engineers, with, I am bound to say, very great success, but I cannot find that this arrangement is made use of as part and parcel of the curriculum of the school, nor does there appear to be any connection between the two establishments.

There are systems of telegraphy in and about Portsmouth, Plymouth, and other fortified places. The construction of these telegraphs is not under the supervision of the school at Chatham, nor of the trained staff under Major Webber. Communications in connection with some of them were addressed to officers of the Postal Telegraph Department which certainly ought to have been addressed to some other source.

In one case upon a railway, where the Postal Telegraph Department possesses right of way, and where no expense need have been incurred beyond that for the erection of the wire, the War Department entered into arrangements with the railway company by which a considerable wayleave was paid; in fact, exceeding by three times the amount paid by the Postal Department anywhere.

It would appear, therefore, that there is wanting some reeognised head in connection with the Military Telegraph system of this country, through whom such arrangements should be made. It may be taken for granted that no permanent success can be obtained until there be unity of management and sustained experience.

Generals do not use telegraphs even now, for the simple reason that they do not trust them, because they cannot secure the prompt and correct despatch of messages. The experience gained in connection with the Autumn Manœuvres consists principally at present of failures, and these failures have been due to imperfect organisation rather than to imperfect equipment. It is certain that confidence cannot be obtained until actual communication can be ensured as well as accuracy and despatch in the transmission of messages, and this can only be assured by incessant practice. Unless generals make use of telegraphs in times of peace, they are not likely to make much use of them in times of war.

(To be continued.)

ON NEBULOUS SPIRALS.

By M. G. PLANTÉ.

If spectrum analysis has in later times allowed us to study the chemical composition of celestial bodies, it is not rash at the present day to seek to give a reason for their physical constitution by the observation of electrical phenomena, and by the inferences that may be drawn from them.

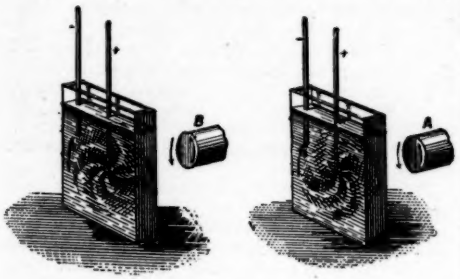
The gyratory movements, accompanied by luminous effects, which I have observed with a powerful flow of electricity, the spherical and annular forms manifested by bodies under this influence, have already led me to surmise the probabillty of the electrical origin of celestial bodies.

I am able now to attribute the same origin to these worlds by a process of aggregation and disaggregation, which constitute the non-resoluble nebulæ, and particularly those which take the remarkable spiral forms.

I have some time since drawn attention to an experiment in which a cloud of metallic matter, attracted to an electrode by a current of electricity in the midst of a liquid, assumes a gyratory movement in the form of a spiral. It will suffice to look at Figs. 1 and 2, which represent this experiment, in order to recognise the exact form of the spiral nebulæ described by Lord Ross, the form of which have the curvature of their rays directed in the reverse direction to which the hands of a watch turn, like the rays in Fig. 1—such, for instance, as the nebulæ of the "Hair of Berenice," &c. Others have their rays directed in the same direction as the hands of a watch turn, as those in Fig. 2, as

for instance, the nebulæ of the "Hunting dogs," &c.*

In the presence of so striking an analogy, are we not warranted in thinking that the cause of these nebulæ can be attributed to a true focus of



electricity! whilst their special form may probably be owing to the presence of a strongly magnetic celestial body in the neighbourhood, and that the direction of the curvature of the rays may depend upon the nature of the magnetic pole turned towards the nebulæ.

We must then seek amidst the stars already known around these nebulæ for those which by their position may exercise magnetic influence, or explore the celestial vault upon the axis around which the spirals seem to turn in this or that direction, in a systematic manner, in order to discover the celestial bodies capable of influencing their forms or their gyratory movements. Further, if a star was found which satisfied these conditions, we should examine it upon the line passing through the centre of the nebulæ, and through the star itself, to see if there is not a point corresponding to the other pole of this star, and a second nebulous spiral having its rays turned in the reverse direction to the magnetic currents of the pole, but nevertheless appearing to the observer, turned in the same direction to those of the first; then the whole of these three bodies thus constitute a symmetrical stellar system. The cosmic matter is spread with such great profusion in space that this hypothesis is quite admissible.

Such researches require the employment of most powerful telescopes. I have suggested these theories to astronomers, with all the reserve which should accompany inductions based upon simple analogy; but if observation justifies the assumption, it will afford a decided proof in favour of the electrical origin of electrical bodies. One might object that it would be impossible for a current of electricity to be conducted in space from the exterior to the centre of the nebulæ; in reply to this objection, I may remark that in other experiments with a source of electricity much more intense, I have observed little luminous rings formed by incandescent particles wholly detached from the electrode; these rings, the middle of which was agitated by a liquid vortex, move in the interval between the electrode and a larger luminous ring, formed in the neighbourhood by the impulse of an electric wave against the partitions of the voltameter. These have the electrical foci separated from the principal ray to which they have given birth, and analogous, although infinitely small, to the origin of the isolated stars, or to those stellar agglomerations, for instance, which constitute the ring-shaped nebluæ of the "Harp," the "Swan," or the "Milky Way."

The last luminous ring which forms the limit of the development of the electric wave in the voltameter can even show the existence of immense nebulous rings hitherto invisible, which envelope all the others, and which is the last wave of the general electric movement of the universe.

* If we consider the moment when the metallic powder is in a state of rotation in the liquid, the resemblance to the rays of this latter nebulæ in particular, is still more marked than in the figure referred to.

BLOCK SIGNALLING.

(Continued from vol. iii, page 290.)

THE introduction of the instrument invented by Mr. Tyer served but to herald the advent of another, somewhat similar in its indications, by Mr. Bartholomew. The outward form of the instrument is shown by fig. 7. The face of the in-

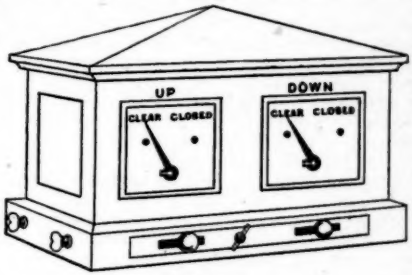


FIG. 7.

strument carried two pointers or indicators—one for the up, the other for the down line. These indicators were maintained in their position by gravity, *i.e.*, they were so weighted and adjusted that when released from the vertical position they would fall to either side; thus the current was required to be strong enough to overcome not only the inertia, but the magnetism by which the needle was held in its last position. The outer indicators were fixed upon spindles carrying an inner needle or magnet, free to move between the poles of an electro-magnet. Placed in front of the poles of the same electro-magnet was an armature, carrying a small hammer, which at every current received was attracted to the cores; the movement effecting a stroke on a bell dome, fixed above the coils for that purpose. There was no record of the outgoing current, or of the signal last sent to the distant signal box. The manipulation of the instrument was by means of two knobs placed below the indicators, and used for the corresponding lines. In effect these were simply reversing keys, which, on being drawn over towards the one side, conveyed a copper current to line, and on being carried to the other side, a zinc current; the normal position of the keys being midway between the two motions, in which position the coils of the instrument were in circuit.

The compactness of the instrument, and the economy with which it could be worked in battery

power, were recommendations in its favour, but these were not such as to secure it a position in advance of Tyer's, even at that period. The signals could be reversed by lightning, whilst the keys required careful manipulation to avoid the transmission of an erroneous signal.

In the fall of 1862, Mr. W. H. Preece produced a form of block signals which may be said to have revolutionized the character of such instruments. In the session 1862-3 of the Institution of Civil Engineers, he laid before that Society a paper which drew considerable attention to the subject. Associated with railways and railway working for so long a period, and devoting to the subject of railway telegraphy considerable attention for some years previous, few, if any, were better able to deal with such a question.

Recognising the fact that one reason why the adoption of block signals had been so slow, was the difficulty of teaching those to whom they had to be entrusted for working, and desirous of breaking down that feeling of isolation which attached —absurd as it may seem, considering its absolute indispensability—to the telegraph branch on almost all railways, be sought to popularise the subject by constructing a system of electric signals which, in form and in mode of working, should resemble the signals in actual use on the line; thus the block signal was made to assume the shape of a semaphore, the arm when at right angles to the pillar on which it was fixed indicating, as with the outdoor signals, *danger*, and when lowered or sheathed within the pillar, *all clear*. Again, as with the outdoor signal a lever was employed to operate it, so with Mr. Preece's electric signal, a small lever was made to actuate it in a manner corresponding to that used for the outdoor signal. Thus the electric system of signals became in form and in manipulation a miniature and a repetition of the line signals with which every pointsman and every railway man was acquainted. A bell with an indicator showing "Signal Off" or "Signal On," and a bell key for working the bell completed the arrangement.

The bell was constructed not only for the purpose of indicating by the number of beats the signal sent, but also to record the condition of the block signal at the distant station with which it communicated. In the old needle, and in Tyers's form of instrument, we see this done by the outgoing current, but not so in Preece's. By an automatic arrangement within the semaphore signal instrument, the indicator of the bell was made to move either to "off" or "on" in perfect consonance with every movement of the arm whenever a signal wss sent upon the bell. The semaphore signal itself thus governed the bell signals.

The importance of such an arrangement cannot be overestimated. To the signalman it is an absolute safeguard against error or oversight. He has before him not only the position of the lever working the semaphore, but the indicator of the bell showing its actual position whether at danger or clear, and he knows that as this signal can only be affected by the current from the distant station, he is fully assured of the operation of the block signal protecting trains coming towards him, for had he not operated it, no such indication would have been returned on his bell.

The principles of these several instruments remain, and in describing the instruments of the present day, the details by which these advantages are secured will be dealt with. For the present, it will be sufficient to remark that the system requires three wires, one for the semaphore governing up trains, another for that governing down trains, and a third for the bell being common to both.

Its characteristics are, assimilation to the outdoor system of signals, both in form and method of working; absolute freedom from error from atmospheric electricity; economy in maintenance —the battery power being in use only when the arm is lowered to all clear—and automatic repetition of position of the block signal worked to the distant station.

Probably no greater compliment has been paid an inventor than that accorded Mr. Preece by Messrs. Walker and Tyer; for the former, very shortly after the introduction of the form of signal adopted by Mr. Preece, added a semaphore indicator to his bell system on the most important sections of the South Eastern Railway; whilst the latter recognised its utility and advantages by replacing the indicating needle formerly in use in his instruments also by a semaphore post with a moveable arm. Thus the semaphore arm is now a characteristic of not only Mr. Preece's, but also of Messrs. Walker and Tyer's instruments.

Before entering upon the detailed description of the several block instruments at present in use, there remains one other form to mention, viz., that introduced by Mr. Spagnoletti, and which came mainly into notice on the opening of the Metropolitan Railway. Practically, it was a single needle instrument, but in place of the indicating needle, it had a disc carrying a card with two indications —"Train on line" on a red ground, and "Line clear" on a white ground. Two pedals, somewhat

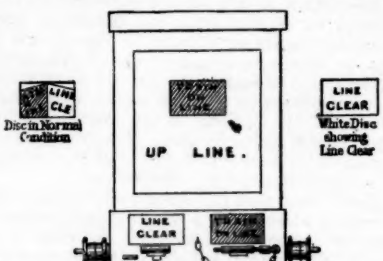


FIG. 8.

similar to those in use for working the Postal Telegraph single needle instrument were employed for operating it. They were coloured to correspond with the indications—red for blocked, white for clear—and could be pegged down, as shown in the cut, so as to maintain either signal constant.

The instrument, being practically a needle instrument, was open to the objections applying to that class of instrument. It was assailable by lightning, by which its signals might be reversed the same as an ordinary speaking instrument of that day. Mr. Spagnoletti's late form has been much improved. It will be fully described in deal-

ing with the signal instruments of the present day.

(To be Continued.)

Notes.

BRYANT and May's safety matches are highly electrical, and if they be rubbed against glass or ebonite they readily ignite, especially if these electrics be dry and warm. How far their ready ignition on amorphous phosphorus is due to chemism, and how far to electricity. remains to be proved.

Nature says that a French clerical journal maintains that the tolling of the church bell is of much greater efficacy than the use of lightning-rods in warding off the effects of a thunderstorm, and advises the faithful to resort to the former means in preference to the latter.

The Anglo-American Telegraph Company have just given notice that telegrams can now be sent to Mexico, but that the lines there do not work very regularly.

Owing to delay in getting the material ready to put down, the Western Union Telegraph Company have decided not to attempt to lay the pneumatic tubes and underground wires between their general office and the branch offices on Broad and Pearl-streets until early in the spring. The work could not be conducted to advantage during the severe winter weather now soon to be expected. No part of the plans regarding the experiments contemplated, however, have been changed.

In transmitting the President's message from Washington to New York on Thursday, Dec. 7th, the Western Union Company used eighteen wires, and the time occupied was 30½ minutes. The message contained about 13,000 words, and copies were dropped at Baltimore and Philadelphia.

We learn from America that the Direct United States Cable Company state that the recent breaking of their cable in the Atlantic cannot be accounted for in any other way than that the break was caused by some vessel, but whether from accident or design is not at present known, and they decline to express an opinion on the subject. They declare, however, that the cable on examination recently was in perfect order, and that considerable force must have been used to disarrange it. The company offered a reward of £1,000 for the discovery of the vessel which broke the cable. The second break has been successfully repaired.

The first annual meeting of the American Electrical Society was held in Chicago on Wednesday, Nov. 17th, and was very largely attended, many members from various sections of the country being present. The president of the society, Gen. Anson Stager, presided.

Mr. Thomas Slater writes that the new prism electro-magnet of M. Sommati, described at p. 277 of our number of Dec. 1, 1875, was previouly invented and patented by him two years ago.

It has recently been recommended by M. Saint Edme that lightning conductors should be constructed entirely of iron, protected by a coating of electro-deposited nickel.

The Direct United States cable, broken on the 10th ult., was repaired on the 10th inst., the *Faraday* having made a successful expedition.

The repairs to the first break were completed in a remarkably short time, especially if the season of the year be considered. The *Faraday* left the Thames, arrived at Newfoundland, completed the repairs, and was back again within a month.

It would seem likely that the present expedition will be equally expeditious. However, it is to be hoped that the direct cable will be left alone for the remainder of the winter, for it would be most desirable that the result of cheap American telegraphy should be known.

The Anglo-American Company's receipts for Saturday the 8th inst., at 3s. per word, amounted to £2,040, and for Sunday to £630; against an actual average in January last year, at 4s. per word, of £1,785.

During a heavy gale off Madeira the line end of the Lisbon-Madeira section of cable was broken. It was repaired in a few days, the fault evidently being easily accessible. The *Hawk* was despatched at once, and will now not be required, as the repairs were completed shortly after her departure.

The Suez-Aden section of the Eastern Company's cable is still broken down. The *Chiltern* has arrived at Aden, but the repairs are still incomplete.

D'INFREVILLE'S DUPLEX TELEGRAPH.

By HUGH NEILSON.

(*The Telegrapher.*)

THOUGH the duplex invention has lately been rather thrown in the shade by its "big brother," the quadruplex, it still remains, and, for a year or two at least, is likely to remain the most reliable means of working off business between large cities, especially when such cities are more than 250 miles apart. If an ordinary Morse circuit between two large cities can carry 350 messages a day, on which the company make a profit, an arrangement by

which the capacity is increased to 700 must of necessity give two profits, while the capital has not been increased except by the extra cost of instruments, which in comparison with the cost of construction and maintenance of another wire, it is not necessary to take into account.

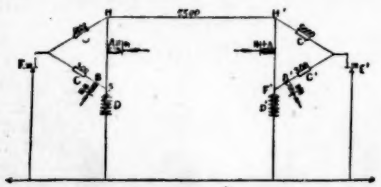
There are at present working successfully in this country five different systems of duplex: 1st and 2nd, the difierential and bridge systems of Mr. Stearns; 3rd, the polarized relay system of Mr. Haskins; 4th, the system of Mr. D'Infreville; and 5th, Mr. Gerritt Smith's arrangement, lately described in the *Telegrapher*. The systems of Mr. Stearns have also been described in the *Telegrapher*. No description, however, has appeared of Messrs. Haskins or D'Infreville's inventions. The former arrangement is working very successfully on the North Western Company's lines between Milwaukee and St. Paul. I hope Mr. Haskins will soon give the fraternity a description of it through your columns. No one can do it better.

All the foregoing systems, except the D'Infreville, use condensers for counteracting the effect of the return current. In Mr. D'Infreville's system condensers are not necessary, the current of charge and discharge being rendered harmless by an arrangement of electro-magnets. Messrs. D'Infreville and Haskins also dispense with transmitters, only ordinary keys being used in their arrangements. The D'Infreville requires no instruments (with the exception of rheostats) which cannot de found in every telegraph office,

In the description of Gerritt Smith's duplex arrangement, given in the *Telegrapher* and *Journal of the Telegraph* a few weeks ago, it is stated that in this, as in all other systems of duplex, it makes no difference whether the batteries at each end are placed with similar or dissimilar poles to the line. The writer of the article cannot be acquainted with the D'Infreville system or he would not have written the foregoing. In the D'Infreville system the batteries must oppose each other, and, if I am not mistaken, I think that in Mr. Haskins' system they must *not* oppose, but be placed in same way as in an ordinary Morse circuit.

In both of Mr. Stearns' systems, and I should suppose in Mr. Haskins' also, it is possible to work other lines from the batteries used for the duplex. I understand, however, that this is not generally done. In the D'Infreville system this cannot be done with advantage, and I think the same remark will apply to Mr. Smith's arrangement.

In these days, however, of sulphate of copper batteries, this cannot be considered a very serious objection. In the diagram two stations are shown



arranged for duplex on Mr. D'Infreville's plan The line is of 7,500 ohms resistance.

A A' and B B' are ordinary relays of 200 ohms resistance.

E E' are ordinary Morse keys with the circuit closer removed.

D D' are main batteries, of equal strength, with similar poles to line. The current from each battery passes through receiving relays A A' to the line, only a very small portion of it going through the shunts formed by the rheostats and recording relays. Of course, as the batteries oppose each other, both receiving relays remain open. By depressing key E we close relay A'. The current from battery D is now short circuited through recording relay B and rheostat C, 300. The current from battery D' coming over the line also takes the same route to the ground, and relay A' at once closes. Relay A, however, remains open, owing to the current coming from battery D', meeting with a sufficient quantity of current from battery D (which leaks past the point F) to balance it. This balance is obtained by varying the resistance in the rheostat C, marked 300, so that when key E is closed (the key at the other end being open) the armature of relay A does not move. Relay A' being thus closed, let us see how relay A can be closed from the other end of the line. We close key E' battery D' being thus short circuited, the current, which before went over the line to preserve the balance at relay A is cut off, and the small portion of current which leaked past point F now goes on to point H, and thence through rheostat C, 5,000, and key E, to the ground, and relay A closes. Relay A', which had already been closed, is kept so by the leakage current, which acts the same way as at the other end. It is thus shown that no matter in what position the keys may be, the relays are always ready to respond to the writing from the other end.

The return current is neutralized by the recording relays B B' as follows:—When the line is at rest it is charged with a current of the same polarity from each battery. When the key at either end is closed the current in the line would, in discharging through the receiving relay, make a false signal; at the same instant, however, the recording relay, through which a strong current is passing, sends out an inductive current, which, running in an opposite direction to the current that produced it, meets and effectually kills the discharge current. On raising either key the line is again charged, and this current is again neutralized by the current given out by recording relay on being demagnetized. The strength of these inductive currents can easily be varied to suit any line or condition of line, by using relays of different resistances and size of core. The arrangement shown in the diagram has been working between Toronto and Montreal, on the Dominion Telegraph Company's lines, a distance of nearly 400 miles, for the last year, and is giving good satisfaction. One hundred and forty cups, of ordinary sized gravity battery, are used at each end.

THE American electric Society have lately furnished a room in the Western Union building very handsomely, which is open to any of its members. They have quite a library—some of the best books on electricity published in this country—and will soon have many others, among which will be some from societies in Europe. They are preparing their first book, which will contain some fine cuts of different late inventions.

THE BAKERIAN LECTURE.

An Account of several new Instruments and Processes for determining the Constants of a Voltaic Circuit.

By CHARLES WHEATSTONE, Esq., F.R.S.,
Professor of Experimental Philosophy in King's College, London, Corresponding Member of the Academy of Sciences at Paris, &c.

Received June 15.—Read June 15, 1843.

(Continued from page 12)

SECTION 10.—*Process to ascertain the Sum of the Electro-motive Forces in a Voltaic Circuit.*—The rheostat affords a most ready means of ascertaining the sum of the electro-motive forces active in a voltaic circuit, without requiring for this purpose the aid of a rheometer graduated to indicate proportional forces, or having recourse to the tedious process of counting the oscillations of a needle, employed by Fechner in his investigations. To save time and trouble in this operation will be of great importance to the future progress of electro-chemistry, on account of the great number of experiments of this kind which yet remain to be made, and also from the fluctuations in the electro-motive forces of many circuits from chemical and other actions, which render observations requiring considerable time to make completely valueless.

The principle of my process is as follows:—In two circuits, producing equal rheometric effects, the sum of the electro-motive forces divided by the sum of the resistances is a constant quantity, *i.e.*—

$$\frac{E}{R} = \frac{n\,E}{n\,R};$$

if E and $\frac{E}{R}$ be proportionately increased or diminished, F will obviously remain unchanged. Knowing therefore the proportion of the resistances in two circuits producing the same effect, we are able immediately to infer that of the electro-motive forces. But as it is difficult in many cases to determine the total resistance, consisting of the partial resistances of the rheomotor itself, the galvanometer, the rheostat, &c., I have recourse to the following simple process, Increasing the resistance of the first circuit by a known quantity r, the expression becomes—

$$\frac{E}{R + r};$$

in order that the effect in the second circuit shall be rendered equal to this, it is evident that the added resistance must be multiplied by the same factor as that by which the electro-motive forces and original resistances are multiplied, for—

$$\frac{E}{R + r} \qquad \frac{n\,E}{n\,R + n\,r}.$$

The relations of the lengths of the added resistances r and $n\,r$, which are known immediately, give therefore those of the electro-motive forces.

Experimentally I proceed thus:—I interpose the rheostat and the galvanometer in the circuit, and then add, by means of the former, assisted if necessary by the resistance coils, a sufficient resistance to bring the needle exactly to 45°; I then ascertain the length of wire uncoiled from the brass cylinder of the regulator necessary to reduce the deviation of the needle to 40°, The number of turns is the measure of the electro-motive force, the number corresponding to that of a standard element having been previously determined.

Section 11.—I subjoin a few measures of electro-motive forces obtained by the preceding process

1. Three elements of different sizes, consisting of copper, a solution of sulphate of copper, and a liquid amalgam of zinc, were successively placed in the circuit. The number of turns of the rheostat requisite to reduce the needle from 45° to 40° were—

Small element described in Section 5 30 turns.
Copper cylinder 3½ inches high and 2½ inches diameter . . . 30 turns.
Copper cylinder 6 inches high and 3½ inches in diameter . . . 30 turns.

Hence, conformably to the theory, the magnitude of an element occasions no difference in its electromotive force.

2. Five small elements of copper and amalgam of zinc were charged respectively with the following five solutions of copper, the sulphate, the ammonia sulphate, the acetate, the per-muriate and the nitrate. Though the force of the current produced by each element separately was very different, owing to the different conductibility of the solutions, yet, with the exception of the nitrate, all required the same number of turns, indicating equal electro-motive forces; the latter fluctuated between 23 and 29, owing to some disturbing action, probably of the nitric acid, on the mercury of the amalgam.

3. The electro-motive forces of a circuit in which 1, 2, 3, 4, 5 similar elements were successively placed, were measured-

1 element required . . .	30 turns.
2 elements	61 turns.
3 elements	91 turns.
4 elements	120 turns.
5 elements	150 turns.

The electro-motive force of a circuit is therefore, as theory indicates, proportional to the number of similar elements of which it is formed, arranged in series.

4. The next experiments were made to determine the amount of the contrary electro-motive force which is introduced into a circuit when a voltameter or decomposing cell is interposed. The liquid in contact with the platinum electrodes was dilute sulphuric acid. The measure of this contrary electro-motive force is obtained by subtracting the actual number of turns from the number corresponding with the electro-motive force of the circuit when the decomposing cell is removed from it.

				Contrary electro-motive force.
3 elements with decomposing cell	21 turns	90 —	21 =	69
4 elements with decomposing cell	50 turns	120 —	50 =	70
5 elements with decomposing cell	79 turns	150 —	79 =	71
6 elements with decomposing cell	109 turns	180 —	109 =	70
			Mean	70

The contrary electro-motive force may be considered therefore in this case to be constant, and to be that of a single standard element as 7 : 3. It is hence obvious why three such elements are necessary to decompose water in a cell with platinum electrodes of a certain size, and charged with dilute sulphuric acid. The amount of this contrary force varies with different liquids, and ac-

cording to the nature of the electrodes employed; as it is not my present object to investigate this subject, but merely to give a few examples of the measures which may be obtained by the abovementioned method, I shall not enter on the consideration of these interesting but intricate modifications.

5. The highest electro-motive force which a voltaic element consisting of two metals and one interposed liquid can manifest, is when the liquid is a solution of a salt of the negative metal, so that by the continual deposition of this metal the negative surface is kept free from the contact of heterogeneous substances which would tend to give rise to a reverse current. When, in consequence of the chemical action, any heterogeneous solid matter is deposited on, or any evolved gas adheres to, the negative surface, the electromotive force of the element is reduced. The following measures will show the reduction in electromotive force of a zinc and copper, and of a zinc and platinum element, by substituting dilute sulphuric acid for the metallic salt; the changes in these cases are affected by the adhesion of hydrogen to the surface of the negative metal.

Amalgam of zinc	Sulphate of copper	Copper	30 turns.
Amalgam of zinc	Dilute sulphuric acid	Copper	20 turns.
Amalgam of zinc	Chloride of platinum	Platinum	40 turns.
Amalgam of zinc	Dilute sulphuric acid	Platinum	27 turns.

6. The proportion of zinc in the liquid amalgam does not appear to affect the electro-motive force of the voltaic element of which it forms part; the number of turns of the rheostat remains the same although the quantity of zinc may vary very conconsiderably. I was therefore led to think that tolerably accurate measures might be made of the comparative electro-motive forces of the alkaline and earthy bases. An element was formed of liquid amalgam of potassium, sulphate of zinc, and zinc; the potassium was in proportion to the mercury less than 2 per cent.; there was no apparent local action, and the current was remarkably constant and continuous.

The following were ascertained to be the electromotive forces of different elements in which the positive metal was amalgam of potassium, and the negative metals respectively were zinc, copper and platinum.

Amalgam of Potassium	Sulphate of Zinc	Zinc	29 turns.
Amalgam of Potassium	Sulphate of Copper	Copper	59 turns.
Amalgam of Potassium	Chloride of Platinum	Platinum	69 turns.

The electro-motive force of the first combination nearly corresponds with that of zinc and copper, and when the resistance in the circuit is equivalent, produces a current having nearly the same degree of force. The third combination is one of great electro-motive energy, and when a voltameter with small electrodes is interposed in the circuit, decomposes the water in it abundantly.

It would not be difficult to submit to experiments of this kind all the alkaline and earthy bases; as the proportion in the amalgam does not seem to be of importance, they might be easily prepared by means of a voltaic battery. It would be interesting to know what rank the hypothetical base of ammonia would hold in this scale of electromotive forces.

7. A still higher electro-motive force may be obtained by employing in conjunction with the amalgam of potassium, a platinum plate covered with a film of peroxide of lead*. Such a plate is easily prepared by making it the positive electrode in a decomposing cell, charged with a solution of acetate of lead. The films thus formed exhibit, as Nobili has shown, according to their thickness, the colours of Newton's rings.

			Turns.
Amalgam of zinc	Dilute sulphuric acid	Peroxide of lead	68
Amalgam of potassium	Dilute sulphuric acid	Peroxide of lead	98

(To be Continued.)

Proceedings of Societies.

UNDERGROUND TELEGRAPHS.—STREET WORK OF LONDON.†

By C. FLEETWOOD.

THE following is an abstract of this paper:—From the original five wires used by Cooke and Wheatstone in July, 1837, to test their five-needle telegraph, the system has increased latterly with rapid strides, 750 wires at the present time entering the central station, St. Martin's-le-Grand, alone, with a total mileage of over 3,500 miles of wire.

On the successful issue of the Cooke and Wheatstone Telegraph, five wires were placed underground in lead pipes between Paddington and Drayton, but became defective in 1841, and were replaced by overground wires on posts.

In 1846, on the incorporation of the Electric and International Company, the lines erected by Mr. Cooke were led by wires in iron pipes to the first office in London, 345, Strand. In the following year the system was extended underground to the new central station, Founder's Court, Lothbury, The total system of the Company at that time reached 1,500 miles, less than one-half of the present street work in London alone.

The length of pipes underground now is 110 miles, consisting of five trunk lines, radiating from the central station, St. Martin's-le-Grand, to the following points:—Hounslow, Clapham Common, New Cross, Maryland Point, Stratford, Bayley's Lane, Stamford Hill, East End, Finchley, north end of Primrose Hill Tunnel, and Harrow Road.

At the central station the whole 700 wires are carried up the interior of the building, and terminate on a test box, where each wire is numbered. Provision has been made on this box for 500 wires from the west, and a corresponding number from the east, a total of 1,000 in all.

A 4-inch pipe will hold 100 wires, and a 3-inch 72. The pipes are 9 feet long, and previous to being laid, are well cleansed inside.

The socket joints are made same as in gas or water-pipe joint.

In marking out the route, the footpath is generally chosen; the pipes are laid under the pavement, it being more accessible than the roadway.

Flush boxes, 2 feet 6 inches long, 11 inches wide, and 1 foot deep, are fixed 50 and, in some cases

* A rheomotive series of ten such elements will have an electromotive force equal to thirty-three elements of Daniell's battery, or fifty of Wollaston's arrangement in good action. Voltaic combinations, in which peroxide of lead is substituted for the negative metal, have been experimented with by Professors Schönbein, (Phil. Mag., 3rd Series, vol. xii. p. 225, March, 1838), and De La Rive (Archives de l'Electricité, No. 7, April, 1843).

† Read before the Society of Telegraph Engineers, December 9th, 1875.

100 yards apart. As the pipes are laid an iron wire is threaded, by which the cables are hauled through.

The cables are sent out in lengths of 400 yards. On arrival at the place where it is to be used about 6 inches of percha is trimmed off the end of each wire, and the whole passed through a loop in the iron leading in wire and secured, a piece of canvas is then wrapped round and fastened with string.

An iron frame with two wooden rollers fitted is then fixed in the flush-box, the cable is made to pass over one roller and under the other, the latter is so arranged that the cable enters the pipe with a clear lead and without being chafed against its edges.

After a few sections have been drawn in, the jointers follow, numbering the wires and making permanent joints.

Within the last five years nearly the whole of the underground wires in London have been relaid. The work has been effected with comparatively ltttle or no interruption of the working circuit, and by less than is experienced from removals on railways or road lines.

The wires are tested periodically from the central station by means of a Wheatstone bridge and Thompson's galvanometer. To prevent stopping the circuits two wires (where available) are used between St. Martin's and the points to which the wires are to be tested, one joined to an instrument for speaking, and the other for substituting the working wire during the time it is being tested. The average insulation is about twelve megohms per mile.

The position of faults are determined by a loop test, and as a rule is very correct. It seldom happens that a joint is found defective, but generally something within the pipes, probably caused by lightning.

If this view is correct, it would be well to have means of fixing lightning protectors at the ends of each underground route.

A few years ago it was customary to cut or prick wires when one was wanted at a point where numbers had not been attached. This was a very dangerous practice, and frequently led to interruptions of working owing to the cuts or pricks not being made permanently good. At the present time, by means of a quantity current and a horizontal galvanometer, a wire can be found at any point of the London street work without any difficulty, by merely placing each wire over the galvanometer.

THE ELECTRO-MAGNET.

At the ordinary meeting of the Manchester Literary and Philosophical Society, Mr. R. Angus Smith, Ph. D., &c., in the chair, a paper was read by Professor Osborne Reynolds, M.A., on "The Principle of the Electro-Magnet constructed by Mr. John Faulkner." Mr. Reynolds stated that the magnet which formed the subject of his paper consists of a soft iron bar with a flat plate attached to one end and surrounded by a coil of wire in the same way as the ordinary electro-magnet. Outside this coil is placed a tube of soft iron of the same length as that portion of the interior bar which projects beyond the plate; this tube has flat ends—one of which is in contact with the plate, while the other comes up flush with the end of the bar—so that a plate or keep placed over the end is in contact with both the bar and the cylinder. The magnet is excited in the ordinary way, by connecting the ends of the wire which forms the coil with the poles of a battery. When thus excited, this magnet exhibits certain peculiarities as compared with a common magnet. In the first place the magnetic field is very limited, being confined to the space in front of the open end of the tube, there is little or no magnetism along the tube or at the closed end. The magnet retains its keep with greater force than the simple bar. Mr. Faulkner has some magnets of this kind which retain the keep with 100 times more force when the outer tube is on than when it is removed. The ratio of these retaining powers appears, however, to depend on the relative diameters of the bar and the tube; the larger the bar in proportion to the tube, the greater is the difference. Some magnets, made especially to test the relative powers, give an increase of only double as compared with the simple bar magnet. This magnet has a greater sustaining power than the horse-shoe magnet. This was shown by putting tubes round the poles of a horse-shoe magnet, by which means it was made to sustain greater weights than it would without the tubes. The object of the paper was to suggest explanations of these phenomena. They were attributed to three principal causes. 1. The tube surrounding the bar unites the poles and converts the magnet into a kind of horse-shoe magnet, the ends of the tube having the opposite polarity to those of the bar. If this were all, however, this magnet would not have any advantage over the horse-shoe magnet. 2. The close proximity of the tube to the bar enables the one pole to exert greater inductive action on the other than in the case of the horse-shoe form. 3. The electro-magnetic action of both sides of the coil is utilised in the same manner as in the astatic galvanometer. The current converts the tube into a magnet of opposite polarity to the bar, and hence these two magnets act upon each other by induction, which their relative positions enables them to do with the greatest effect. It appears from the researches of Dr. Joule that the larger the bar inside the coil the less will be the intensity of magnetism exerted in it by the coil. While it may be shown that the smaller the tube—the closer it is to the coil—the greater will be the intensity of magnetism excited in it. Also the inductive action of the iron in the tube on that of the bar is inversely proportional to the square of the distance between them. Hence it follows that the effect of using the outside as well as the inside of the coil must increase rapidly as the diameter of the bar approximates to the diameter of the tube. After the reading of the paper, Mr. Faulkner exhibited some of his magnets; and by means of iron filings scattered on sheets of paper produced some very beautiful diagrams illustrating the effect of the outside tube on the magnetic field.—*Manchester Courier, Dec.* 1, 1875.

THE CHRISTMAS LECTURES AT THE ROYAL INSTITUTION.

By PROFESSOR TYNDALL

Fifty-one years ago it was proposed by the Com-

mittee of Management of the Royal Institution that a course of lectures specially adapted for "a juvenile auditory" (to use their own words) should be delivered every Christmas in the theatre of the institution. Arrangements seem to have been at once made for carrying this proposal into effect, and a Mr, Wallace was to give the first series upon astronomy. It is questionable, however, whether these were actually delivered; and it is not until the following year, namely 1827, that all doubts upon the subject are removed, and we can accept for certain that the initiative was taken in the scheme which had been proposed two years before, and which now, after the lapse of well nigh half a century, gives evidence of its popularity by the crowds which year by year it draws to Albemarle-street. It was in the Christmas-tide of 1827 that Faraday first made his appearance before "a juvenile auditory" at the Royal Institution. From that year up to his retirement from active life, his Christmas lectures formed some of the brightest spots in his career, and to those who has the good fortune to listen to him, they have now become one of the happiest memories in connection with his name.

Last year's course, it will be remembered, was delivered by Dr. Gladstone, on the subject of "The Voltaic Battery," and the series of lectures was afterwards published in the *Telegraphic Journal*. This year's course was commenced on the 28th December, by Professor Tyndall delivering the first of a series on "Electricity." The warm burst of applause which the mention of Faraday's name at the outset evoked from the young people, who crowded the front seats of the theatre, gave evidence of the fact that the memory of that "just and faithful knight of God" was warmly cherished by those who can have known him only by name, while the sympathetic cheers which broke from the lips of the elders, who were present, showed that still—

"He is a presence to be felt and known."

And become in sooth—

"A portion of the loveliness
Which once he made more lovely."

Of the lectures it is needless to say that they have been a brilliant success from first to last. Professor Tyndall might have spared himself the trouble of even alluding to what one hears from time to time put forward, that "boys don't like science." His own efforts were the most convincing proof to the contrary, and exhibited more clearly than any other arguments could have done the utter fallacy of the statement. The interest of his young audience never flagged for a moment, and so thoroughly does he succeed in infusing into the minds of his hearers a portion of that enthusiasm which inspires his own, that there was a positive sigh of disappointment at the end of each lecture, when the allotted hour had expired and the subject had to be adjourned to the next meeting. In the "Lessons on Electricity," as the course is named, we cannot look for anything new.

The elementary facts are placed before us as clearly as the most popular of science-teachers can place them. Much sound advice is inculcated into the minds of the young philosophers who are present, and over all is thrown the charm of the most successful and entertaining of experiments. In connection with them the simplest possible materials are employed. The lessons are made "suitable for boys without much pocket-money, and economy is consequently aimed at." In fact, the entire stock in trade required for the philosopher to commence business in electricity with may, Professor Tyndall assured his hearers, be purchased for the sum of four shillings. He rightly urges, with all the vigour at his command, the value of *experiment*, and cogently points out how "it was the neglect of experiment, and of the reasoning based upon it, which kept the knowledge of the ancient world confined to the attraction of amber for more than 2,000 years." Too much stress cannot possibly be laid upon this, and not only is it true of electricity; it applies with equal force to every branch of physical science. Experiment is well named the language addressed to Nature by the philosopher, and only by constantly repeating his enquiries in that language can he hope to draw from her a satisfactory reply to them. No greater master of experiment than Professor Tyndall exists at the present day in England, and in this respect at least the mantle of Faraday has, in him, fallen on no unworthy successor. A higher meed of praise than this it would be impossible to accord to him. Most of Professor Tyndall's experiments, illustrating the phenomena of static electricity, are already familiar to readers of the Journal; one which we have not seen before deserves, however, to be mentioned. From a glass vessel, a stream of fine sand is kept constantly issuing; an electrified glass rod is brought into close proximity, and the particles of sand, instead of running on in a continuous stream, are thrown off in the form of a fine spray like the water from a fountain.

The usual success attended all the other experiments, every one of which seemed to be fully appreciated by an enthusiastic audience. In fact, whether regarding it in the light of amusement, pure and simple, or taking the higher ground of combining instruction with pleasure, we know of no more pleasant way of spending an hour in a holiday afternoon than by taking a "Lesson in Electricity" from Professor Tyndall at the Royal Institution.

We extract from the *Illustrated London News* the following short and admirable reports of the lectures:—

I.—Electric Attraction and Conduction.

Professor Tyndall began a course of six lectures on Frictional Electricity, adapted to a juvenile auditory, on Tuesday last. After alluding to the proposition of the Christmas course fifty years ago, the first having been given by Faraday in 1827, he expressed his wish to show in the present course how the facts and principles of frictional electricity may be illustrated and explained by simple, inexpensive apparatus. He then briefly noticed the progress of our knowledge of the subject. For more than two thousand years the only known fact was the attraction of light bodies by rubbed amber ("elektron," in Greek); but in 1600 Dr. Gilbert showed that gems, stones, glass, resins, and many other bodies possess the same power as amber. Robert Boyle, in 1675, proved that suspended rubbed amber is itself attracted by other rubbed bodies. Otto von Guericke, the inventor

of the air-pump, obtained electric power from rubbed sulphur, and the Academy del Cimento made still further advances, proving that smoke is attracted, but not flame, and that a little eminence is formed on the surface of liquids, when subjected to electric attraction. Sir Isaac Newton, by rubbing a flat glass, caused light bodies to jump between it and the table; and Dr. Wall demonstrated flannel to be the best rubber for amber. Dr. Tyndall then commented on the great importance of the art of experiment, which can only be acquired satisfactorily by patient repetition. "By so doing," said he, "you will come in direct contact with natural truth; you will think and reason, not upon what has been said to you in books, but on what has been said to you by nature. Thought springing to you from this source has a vitality not derivable from mere book knowledge." He then placed before his auditors very simple apparatus, such as sticks of sealing-wax, glass tubes, a fox's brush, pieces of clean flannel, and silk ribbon; and he showed how a delicate electroscope may be made by a piece of straw, supported by a sewing-needle inserted in a stick of sealing-wax attached to a tin plate; and also exhibited the manufacture of the amalgam spread on silk-rubbers to render them more efficacious. This was succeeded by numerous examples of electric attraction produced by sealing-wax, guttapercha, and other bodies rubbed with flannel, and by glass rubbed with silk. A jet of sand passing through a funnel, oil in a watch-glass, an umbrella balanced in a wire cradle, and even a boy placed on a balanced board, were shown to be readily affected by the force of electric attraction. A very simple means of exhibiting this attraction was also given by balancing a lath of wood on an egg, in an egg-cup, the lath being powerfully drawn by an ebonite comb passed through the hair, and by paper rubbed by indiarubber. Such electrified paper adhered to a warmed board. The latter part of the lecture was devoted to electric conduction, discovered by Stephen Gray in 1729. When experimenting upon a glass tube stopped with cork, he observed that the cork attracted light bodies when the glass was rubbed; and, on proceeding, he found that not only a stick, but that long pieces of wire, attached to the cork, possessed the same power. He also discovered that silk, when wetted, acquired the power of conducting electricity, which it did not possess when dry. In conclusion, Dr. Tyndall explained the construction of the gold-leaf electroscope, and exhibited its delicate action.

II.—Properties of frictional Electricity.

In his second lecture on Experimental Electricity, given on Thursday week, Professor Tyndall resumed his illustrations of conduction, by means of simple inexpensive apparatus. He described and imitated the way in which Stephen Gray transmitted electricity through great lengths of thread and wire. One end of a long wire was connected with the plate of the electroscope, and the other end was fastened to a glass tube. When the tube was rubbed the leaves of the electroscope diverged, which proved that the electricity produced had passed through the wire. The Professor next showed that some bodies readily conduct electricity, others only partially, and others not at all; and he then stated that the old division of bodies into "electrics" and "non-electrics," was really a division into "conductors" and "insulators." When good connection with the earth exists, all signs of electricity in any body disappear; and when so called non-electric bodies are properly insulated and excited, electric action is immediately manifest. Thus, an apple, a potato, and other substances were readily electrified by friction with fur when they were insulated by suspension with a silk string. The Professor also insulated, first his assistant and then himself, by standing on a board placed on four warmed tumblers. When struck on the back with a fox's brush they each attracted a balanced lath to their fingers by the electricity which had been stopped in its passage to the earth by the glass insulators. Du Fay's important discovery of the existence of two kinds of electricity was next explained and fully illustrated. That philosopher observed that gold leaf was first attracted and then repelled by the same excited body; that when it was repelled by rubbed glass it was attracted by rubbed resin, and that when it was repelled by rubbed resin it was attracted by rubbed glass. These two kinds of electricity were termed "vitreous" and "resinous"—improperly so, since it has been shown that the kind of electricity produced may be reversed by changing the rubber. It is now agreed, merely for convenience sake, to term vitreous electricity positive and resinous negative. The remainder of the lecture was devoted to numerous illustrations of the following fundamental law of electric action—Bodies charged with the same electricity repel each other, while bodies charged with opposite electricities attract each other. The examples of repulsion included strips of cut paper and the particles of a jet of sand.

(To be Continued.)

THE NEW FORCE.

(From the *Journal of the Telegraph*.)

The "new force" claimed to have been discovered by T. A. Edison, may be demonstrated in the following manner:—

Upon an insulated table place an ordinary Morse key and an electro-magnet, the coils of which are so wound that no magnetism is produced in its cores by the passage of an electric current. Use for an armature a piece of the metal cadmium, to one end of which fasten a flat spring. The other end of the spring attach rigidly to a standard fixed on the table. Adjust the armature a short distance away from the core of the magnet. The standard is to be connected by wire to one end of a glass rod or tube, say two feet long. The other end of the tube connect by wire with a graphite point (a lead pencil will answer). Another graphite point is connected by wire to a gas pipe or other suitable mass of metal, not in contact with the apparatus, and the two points, in position similar to the arrangement for producing the electric light, may be placed in a box from which light is excluded, but with a hole in the top for observation. Place 10 or 15 Bunsen cells in circuit with the key and the coils in the usual manner. Now, if the key be closed, a spark of considerable brilliancy will

be evolved from the graphite point, but possessing no continuity. If, however, (the battery circuit remaining closed), any part of the connection between the gas pipe and the cadmium is broken, and contacts be made either slowly or rapidly between the disconnected points, the spark re-appears at each contact. It is here that the phenomena are surprising, and apparently unexplainable. The graphite is not in the battery circuit, nor in any other. Moreover it is separated from the rest of the apparatus by the glass tube. This alone would seem to prove that the force is not electrical, at least as the term is generally understood, and when supplemented by the fact that the most delicate galvanometer and the most sensitive of chemicals to the electric current fail to note its presence, this conclusion must be accepted. Many experiments have been made with a view of obtaining some definite knowledge, but nothing has been developed beyond the facts above stated, and in addition, that like electricity the new force passes through or over some substances better than it does over others, and also that as the resistance of one of its best known conductors is increased by length, the spark decreases in brilliancy.

The occurrence of this spark has frequently been observed by electricians whilst conducting experiments, but heretofore no attempt has been made to discover the cause or effect. Any theory upon the subject is, of course, at present wholly speculative, but it is not improbable that the phenomena are in some degree the physical manifestation of that mysterious magnetic power which is not obstructed by material obstacles and is weakened only by separation. This view is supported by the analogy existing between two demonstrated facts. First: When the new force is conducted through the human body from points attached to both sides of the neck, the spark is of a certain strength. When the connection is through the trunk, from hand to hand, the strength is greatly diminished.

Second: Substances which act as dielectrics offer no obstruction to the passage of magnetic power. The action of a magnet upon a needle is the same when separated only by a distance of air equal to the thickness of the dielectric, and is diminished only by wider separation.

Notices of Books.

The Postal Telegraphs and the Retrograde Steps of the Treasury Committee. By WILLIAM SAUNDERS. London: The "Central News," 107, Fleet Street.

MR. SAUNDERS handles very roughly the Report of the Committee appointed by the Treasury to investigate the administration and financial condition of the Telegraph service since its transfer to the State. This report was at first fondled, and afterwards torn into ribbons, by the *Times*. A reign of terror was thus inaugurated against the Telegraphs, which, based on error, has quietly subsided. He shows very fairly how erroneous were the conclusions of the Committee, and that the surplus of receipts over expenditure in 1874 was £170,000 and not £36,000, and for the five years ending March, 1875, it was £768,000. The facilities afforded for telegraphy have caused the number of telegrams to increase from six millions to over nineteen millions annually, and he deprecates any change in the charges and conveniences which have produced this result. He, however, repeats the absurd error that each message involves the sending of fourteen words as "service instructions," and he estimates the number of necessary and non-paying words to each message as *twenty-three!* He draws a very fair difference between the penny post and telegrams, and shows that any argument for reduction of tariff, based upon an analogy of the two, must be erroneous. The same mails and the same deliveries may carry a largely increased number of letters, but telegrams cannot be increased without a proportionate increase of cost. He argues that the penny per word tariff proposed by the Commission would make the charge for each telegram 2s. 5d. instead of one shilling, forgetting the influence of the word tariff in reducing the number of words in a message. It is well known that on the Continent each message averages under twenty words, why should they average twenty-nine in England?

He instances the effect of high rates by the statement of a firm of shipbrokers, that with the charge of four shillings the captain only telegraphed his arrival to his wife; with a charge of two shillings, the captain and mates did the same; but with a charge of one shilling, the captain, mates, and sailors, all gladdened the hearts of wives and sweethearts by the announcement of their safe return.

Of course Mr. Saunders, as is natural, waxes eloquent on the privileges accorded by the new *régime* to the press, and the difference in their treatment now as compared with former days. It bestows a just tribute of praise upon Mr. Scudamore, for his temper, tact, and talent, and he makes one or two practical suggestions for the improvement of the press service. His pamphlet is an interesting addition to the literature of Postal Telegraphy.

Physical Geography, or the Terraqueous Globe and its phenomena. By W. D. COOLEY. London: Dulau & Co., Soho Square.

PHYSICAL geography is that branch of science which treats of the course of physics reigning on the earth's surface, It deals with the effects of nature over land, sea, and air. Descriptive geography—the so-called geography of our schools—deals with the contour of the earth, its countries, and its peoples, but physical geography shows how heat and light, chemism and electricity have so acted on earth, air, and water as to form them into the earth's surface as we find it, and prepare it for the habitation of organic beings. The telegraph engineer is interested in physical geography, so far as it explains to him the character and construction of the bottom of those oceans, seas and rivers he must cross with his wires, and as it deals with those elemental and cosmical causes which disturb the working of his circuits.

This very interesting instructive work commences by showing the part the earth plays in the heavens, its form and dimensions, and its theoretical and practical representation by maps and charts. It then deals with its constitution, and the part heat

plays in its changes with the atmosphere, its composition, pressure and temperature; with the winds, rains and snows; with the ocean: its depths, waves and currents; with ice and snow; with all causes operating on life and form.

A very interesting chapter is devoted to the nature and power of electricity as evinced in the atmosphere. Its periodical variation, annual and diurnal is described, and the part it plays as lightning, in various forms, dwelt upon. He accepts De la Rive's theory that the atmosphere owes its electricity to the evaporation of the sea, but adds that the agitation of the air with aqueous particles sufficiently accounts for it. Trombes and waterspouts are highly electrical.

"Vapour taking the gaseous form becomes much lighter than air, and favoured by the decrease of pressure ascends to a great height in the atmosphere. It thus enters the sphere of the strongest positive electricity, but the instant that it changes into fluid molecules it is invested with electricity of which water is a conductor. Consequently the molecules having all the same electricity, repel each other, and repelling the dry air also, they obtain buoyancy at a certain elevation. In this condition they form a cloud . . . . Clouds may, in consequence of induction or contact with land, or through a fall of rain, change their electricity, and be either positive or negative. The sun's heat causes ascending columns of air and vapour that carry with them the negative electricity of the ground. The clouds thus formed are attracted towards and clash with those from above of positive nature—a thunderstorm ensues, and the two electricities combine. Clouds in the thunderstorms are charged conductors of electricity, but they are flexible conductors. The electricity is not equally spread over them, but has greater tension at every prominent point, or where there is a larger proportion of surface. These all hurry forward to meet the foremost points of the opposite array. Hence the commotion and rapid change of figure observable in clouds during a thunderstorm."

The peculiarities of hail and its connection with atmospheric electricity, its more frequnt falls in spring and summer than in winter, its accompaniment of thunderstorms, and the irreparable injury to fruit trees and vineyards are described.

Terrestrial magnetism and aurora boreales; light, and its phenomena; the part changes in the climate of the earth; the origin of the ocean and mountains; the effects of denudation, and volcanoes; subsidence and elevation of land in forming the present configuration of the globe, complete a well-digested, ably-written work. Doubtless the author has ventilated many hobbies and crotchets, for who is free from them, but the book is a mass of very useful information, the result of great reading and thought, on many valuable questions.

Telegraphy. By W. H. PREECE and J. SIVEWRIGHT London: Longmans and Co.

THIS long announced book is at last published. It forms one of that excellent series of text-books published by the great house of Longmans that includes Fleeming Jenkins' "Electricity and Magnetism," Goodeve's "Elements of Mechanism," Clerk Maxwell's "Theory of Heat," Anderson's "Strength of Materials," &c. Its price is 3s. 6d., and its size handy in the extreme. It contains 300 pages of closely printed matter, and is excellently illustrated with 161 woodcuts. After defining the terms ordinarily employed in telegraphic language, a description is given of the various forms of batteries used by different administrations, and plain directions are given for their maintenance and renewal. All the different forms of apparatus in use in England are next fully described and illustrated, and a comparison drawn of their relative merits and special adaptabilities. We have next a chapter on circuits, their various kinds, and the way in which apparatus is connected up. This is succeeded by a chapter on special telegraphy, in which automatic, duplex, and submarine telegraphy are very fully examined. The construction of overground and underground wires is then detailed with much minuteness, including the various processes for preserving timber, the different forms of iron poles, the manufacture of iron wire and the various forms and character of insulators and insulating material.

A chapter is devoted to the different kinds of faults to be met with in working telegraphs, and the means adopted for their removal and prevention, and another to testing materials and circuits. Lastly, the method adopted in forwarding and receiving messages is narrated.

Although the book is adapted for the use of students generally, it is written specially for those numerous operators and artisans who are employed in the actual transmission of telegrams, and in the maintenance of telegraphs. It is independent of theory, and is intended to serve as an introduction to more advanced works, such as Culley's Handbook. Submarine cables are not dealt with, nor the more abstruse kinds of telegraphy, such as quadruplex and multiplex working. It is a book which cannot fail to be of use to telegraph clerks, and it brings down telegraphy to the latest phase of form and construction.

TEST OF GALVANISED IRON WIRE.

A RECENT test of six examples of galvanized iron telegraph wire gave the following results:—

	Length.	Weight.	Resistance.	Temp.
B	29,833 ft,	1.656 lbs.	.1577 Ohms.	62° Fahr.
C	20.79 ,,	1.6473 ,,	.11367 ,,	,,
E	30.58 ,,	1.664 ,,	.0816 ,,	,,
M	29.47 ,,	1.5547 ,,	.11356 ,,	,,
O	31.375 ,,	1.719 ,,	.116 ,,	,,
S	29.04 ,,	1.5 ,,	.10621 ,,	,,

The resistances given above are the mean of two measurements, one made with Elliott's slide, and the other with Elliott's large box of resistance coils. The mean resistance in ohms per mile was as follows:—B 27.91; C 23.69; E 15.47; M 20.35; O 19.52; S 1931.

The weight of metal required per mile for one ohm is as follows:—B 8180.21; C 6917.3; E 4446.31; M 5666.61; O 5647.7; S 5266.6.

The number of twists in six inches were as follows:—B 32. C 15. E 16. M 19. O 15. S 22.

Breaking weight:—B 1242 pounds; C 1100; E 900; M 935; O 1028; S 930.

Percentage of elongation. Length of wire tested six inches. B 18.23 per cent.; C 19.79 per cent.; E 7.36 per cent.: M 17.18 per cent.; O 15.63 per cent.; S 15.63 per cent.—*Journal of the Telegraph.*

EFFECTS OF STRESS UPON THE MAGNETISM OF SOFT IRON.

In the physical laboratory at Glasgow University, Sir William Thomson stretched steel and soft iron wire, about twenty feet long, from the roof. An electro-magnetic helix was placed around a few inches of the wire, so that the latter could be magnetized when an electric current was passed through the former, the induced current thus produced in a second helix outside the first being indicated by a second galvanometer. When steel wire was used, the magnetism diminished when weights were attached to the wire, and increased when they were taken off; but when special soft iron wire (wire almost as soft as lead) was used, the magnetism was increased when weights were put on, and diminished when they were taken off. Afterwards he discarded the electrical apparatus; and by suspending a piece of soft wire near the magnetometer consisting of a needle, a small fraction of a grain in weight, with a reflecting mirror attached, the wire was magnetised inductively simply by the magnetism of the earth, and changes in its magnetism were made by applying weights and strains, the changes being then indicated by the magnetometer.

In the Paris International Maritime Exhibition there is a small object deserving of notice. It is a platinum wire placed in a bottle and ignited by electricity from a bichromate battery. It is intended to be immersed in the sea, and the light emanating from it is said to attract an immense number of fishes. Experiments have been tried lately on the coast of the Cotes du Nord department with a fishing boat, and have proved very satisfactory. The glass must be green or black, otherwise the fish are frightened by the glare and do not follow the submarine light.

Researches on Magnetic Rotatory Polarization.—M. H. Becquerel.—Since Faraday's discovery, the phenomenon of magnetic rotatory polarization has been the subject of numerous researches. It has been remarked that bodies strongly refractive have generally also a great magnetic rotatory power; but the exceptions to this rule have hitherto prevented any connection between these two physical attributes from being established. The author finds in his experiments that many bodies present a regular increase of rotation as the index of refraction augments. The exceptions observed may be attributed either to the effects of lamellar polarization, as in the diamond and garnet; or to the presence of magnetic bodies; or, lastly, to unknown causes.—*Comptes Rendus*, vol. lxxx., No. 22.

The traffic receipts of the Direct Spanish Telegraph Company, for the month of December, 1875, were £1,375 13s. 2d.; against £1,271 15s. 4d., in the corresponding period of last year.

Correspondence.

To the Editor of the Telegraphic Journal.

Sir,—It may not be uninteresting to some of your numerous readers to know that a very efficient means of signalling by night may be obtained by the ordinary Benzoline spirit lamp. Most of these lamps are made with very thin metal, and when the light is turned very low and a slight pressure is put on the lamp with the hand, the flame increases in size and brilliancy for an instant and then resumes its former condition. By regulating the amount of pressure on the lamp the "Morse alphabet" may be very distinctly signalled, and it is possible to make signals which may be easily read some distance off by means of a very common lamp costing 6d. It would be possible to construct a lamp very cheaply to give better results, although for experiment or teaching the alphabet the common lamp is quite sufficient.

I am yours, &c.,
A. J. Frost,
Ass. Soc. Tel. Eng.

Electricity as an Executioner.—The revolting scenes accompanying the execution of criminals are well calculated to bring to public notice the disadvantages of hanging as a mode of capital punishment. Instead of building a gallows and providing rope, the sheriff, advised by a competent electrician, would procure a powerful Ruhmkorff coil and a heavy battery. These instruments would rarely need replacing, and would last indefinitely for other executions. The battery and coil should be of sufficient strength to deliver an eighteen inch spark. In case of there being more than one person to be executed, all of the condemned would be conducted with all due ceremony to the place of execution, the left hand of one man handcuffed to the right hand of his neighbour, and the conducting wire fastened to bracelets on the disengaged wrists of both criminals, if only two are to be hanged, or to the wrists of the outer men, if more than that number are to suffer. The culprits being seated so as to be seen by the legal witnesses, the sheriff presses a button. The current is instantly established from the coil, passes through the bodies of the men, and all is over. With a competent electrician, who might be a member of the police force, and specially charged with the duty, there would be no possibility of mistakes. The same ignominy which attaches to the gallows would be transferred to this mode of destruction, while the peculiar death by lightning, which, among the ignorant of all nations and ages, has been the subject of profound superstition, would, without doubt, through its very incomprehensibility and mystery imbue the uneducated masses with a deeper horror.—*Scientific American.*

To Correspondent.

. Duly authenticated contributions, theoretical and practical, on every subject identified with the interests to which "The Telegraphic Journal" is the organ, will always command attention. Anonymous correspondence will be wholly disregarded. Literary communications and books for review should be addressed to the Editor; business communications to the Publishers, 10, Paternoster Row, E.C.